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FIELD EXPERIMENTATION DESIGN FOR MULTI-THREADED ANALYSIS

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I. INTRODUCTION

A. Program Description

The Rapid Force Projection Initiative (RFPI) Advanced Concept Technology Demonstration (ACTD) was an Office of the Secretary of Defense (OSD) sponsored initiative, which leveraged the Army's RFPI Integrated TechnologyProgram. The RFPI ACTD demonstrated advanced technologies and systems to allow early entry forces to defeat normally overmatching armored forces. Through application of the Hunter-Standoff Killer (H-SOK) operational concept, the RFPI ACTD demonstrated reduced timelines for target acquisition, real-time target data transfer, improved situational awareness, enhanced weapon-target pairing, and standoff engagement of targets. The benefits of a lightweight combined H-SOK force arrayed against heavy armor were examined in a large scale, free play, field experiment during FY 98.

B. Scope

The purpose of this report is to describe the analysis requirements, process, products, and agency responsibilities for the RFPI ACTD. RFPI analysis was accomplished examining available data provided by participating Technology Demonstration (TD) and Advanced Technology Demonstration (ATD) experiments and demonstrations, and from RFPI-specific analytical and experimental events. This report does not address analysis requirements for ATDs or TDs, but references relevant ATD/TD analysis where it exits.

II. ANALYSIS DEFINITION

The OSD ACTD Master Plan states that the primary objective of an ACTD is “to provide the decision makers with an opportunity to fully understand the operational potential…prior to an acquisition decision.” By this definition, the entire RFPI ACTD can be considered a series of analyses and assessments of operational potential to support decisions to go forward into various stages of acquisition with combinations of sensors, communications, and weapon systems. Likewise, RFPI analysis is defined by the flow-down of questions that describe operational potential mapped against the analytical and experimental events that constitute the program, culminating in assessments sufficient to provide decision makers with the operational and predictive data needed to transition program elements.

A. Analytical Responsibilities

The analytical process pervades the entire RFPI organization, including elements of the joint managers, ATD/TD managers, TRADOC, FORSCOM, and independent test, analysis, and assessment agencies. Figure 1 is a graphical representation of the Analysis Lead Organizations, and their relationship to the ATD/TD’s and User agencies:

- OPTEC: Assessment Role
- TRAC: Force Effectiveness and Utility
- RFPI: Analysis and Integration

RFPI ANALYTICAL RESPONSIBILITIES

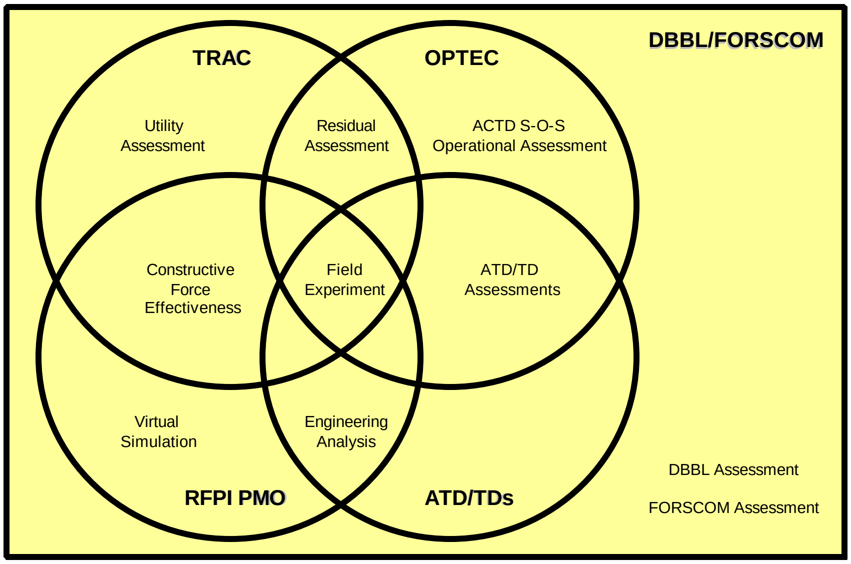

Figure 1. RFPI Analytical Responsibilities

1. RFPI Joint Managers

Specific responsibilities per organization are defined in the subsequent paragraphs:

The RFPI joint managers shared responsibility for the approval of all analysis plans and activities. They provided guidance and requirements defining analytical products in support of Transition Initial Production Test (IPT) actions and decisions. These joint managers were responsible for all model and data accreditation for use in analytical events, and approval for release of all analytical products.

The joint managers convened and chaired the RFPI ACTD Steering Committee that was responsible for configuration management, validation, and certification of all technical data used in ACTD simulations and analyses. The RFPI Steering Committee included representatives from U. S. Army Training and Doctrine Command (TRADOC), U. S. Army Materiel Systems Analysis Activity (AMSAA), Operational Test and Evaluation Command (OPTEC), and U. S. Army Test and Evaluation Command (TECOM). The RFPI Steering Committee established and provided direction to Process Action Teams (PATs) and working groups which addressed special issues, such as C2, sensor and weapon system development and integration, and range survey and evaluation. The Technical Program Manager (TPM) and the Advanced Warfighting Experiment Manager (AWEM) reviewed ACTD hardware, and simulation and analysis products, and approved and accepted these products.

RFPI Simulation and Analysis, Engineering, Test and Evaluation, and the Dismounted Battlespace Battle Lab (DBBL) directly supported the RFPI Joint Managers.

a. RFPI Simulation & Analysis

The RFPI Simulation & Analysis Manager was responsible for the development of this Analysis Management Plan and the RFPI Simulation Support Plan. In addition, the manager was responsible for the management of all operational analyses in coordination with DBBL and virtual simulation activities beyond those conducted entirely within ATD/TD organizations. The manager was responsible for coordination with live and C3 interfaces and scenario developers. The manager chaired the RFPI Integrated Battlefield Simulation and Analysis Team (IBSAT), the product action team supporting model and data verification, validation, and certification, staffed by representatives from all other activities with analysis responsibilities as described in this document.

b. RFPI Engineering

The RFPI Chief Engineer was responsible for the management of all engineering analysis and System-of-Systems Architecture (SOSA) integration activities including the requirements, design, analysis, integration, and Engineering Assessment of the SOSA and RFPI Field Experiment. He was also responsible for the management and coordination of any life cycle cost analyses to address the ACTD affordability issue in the dendritic.

c. RFPI Test & Evaluation

The RFPI Test & Evaluation (T&E) Manager was responsible for the development of the Demonstration and Evaluation Master Plan (DEMP), with the support of the DBBL. The T&E Manager was responsible for the development, integration, implementation, and assessment of all instrumentation for SOSA field experiments. He was also responsible for management of field data collection, reduction of raw data, and creation of Data Element Library for the experiment.

d. Dismounted Battlespace Battle Lab (DBBL)

The DBBL was responsible for the development of the RFPI Organization & Operations (O&O) Concept, Operational Architecture, RFPI Functional Dendritic and the TRADOC User Assessment, as well as support of the development of the DEMP and the RFPI Analysis Management Plan. DBBL chaired the Integrated Concept Team (ICT), with primary membership from TRADOC and U. S. Army Forces Command (FORSCOM) organizations, as well as ATD/TD, RFPI Technical Program Management Office (TPMO), and other agencies. DBBL was responsible for the development of all RFPI Tactics, Techniques, and Procedures (TTPs), and the approval of all simulation implementations of operational concepts, tactics, scenarios, and vignettes. The Advanced Warfighting Experiment (AWE) Manager had primary responsibility for the RFPI Field Experiment, as defined in the RFPI ACTD Management Plan. DBBL was responsible for the management of all Battle Lab Warfighting Experiments (BLWEs), and coordination through Simulations, Training and Instrumentation Command (STRICOM) of all activities in the Land Warrior Test Bed (LWTB). DBBL coordinated all soldier operators/role players participating in program events.

2. U. S. Army Materiel Systems Analysis Activity (AMSAA)

AMSAA was involved in RFPI through reimbursable funds, with delegated responsibility from the joint managers for primary support of verification, validation and data certification. AMSAA provided certified classified and unclassified data sets to support specific RFPI events. AMSAA also provided consultation support of the planning and integration of experiments and analyses, based on their experiences in the A2 ATD program and their data certification process.

3. TRADOC Analysis Center-White Sands Missile Range (TRAC-WSMR)

As responsible for input into the overall RFPI ACTD analysis, TRAC-WSMR represented TRADOC and the user in the analysis process by membership on the RFPI ACTD Steering Committee, and on other committees as assigned by OSD, DA, TRADOC, USAIC DBBL, or the RFPI TPMO. Part of this membership was the attendance by a TRAC-WSMR representative at planning, review, and other meetings involving RFPI. Also, TRAC-WSMR reviewed the DEMPs for the RFPI ACTD and each component TD and ATD, as well as existing experimental, analysis and data collection plans. TRAC-WSMR also supported the other members of the steering committee, i.e., OPTEC, TECOM, and AMSAA.

4. Operational Test and Evaluation Command (OPTEC)

OPTEC provided an operational assessment of the "system of systems" demonstrated during the RFPI ACTD field experiment. Operational assessments were provided for the individual systems' demonstrations prior to, during, and after the ACTD field experiment. Two assessment reports were published – one after the RFPI ACTD field experiment, and one at the conclusion of the residual period. Individual system assessments were provided as annexes to these reports, and as standalone reports to the individual system program managers.

5. U. S. Army Forces Command (FORSCOM)

The XVIII Airborne Corps supported the RFPI ACTD with the 101st Airborne Division (Air Assault) as user/operators of the RFPI residual equipment, and as the role players and staff for the Field Experiment. The 101st Airborne Division (Air Assault) defined and conducted all residual period training activities during which operational suitability data was collected. These elements were responsible for the development of the FORSCOM User Assessment.

6. Advanced Technology Demonstration/Technology Demonstration (ATD/TD)

ATD and TD managers were responsible for conduct of all activities that define and assess their own system performances. ATD/TD managers were responsible for reviewing RFPI models and data to support the verification, validation, and certification process, through the RFPI IBSAT, and operational implementations through the ICT.

7. RAND

RAND was responsible for independent Counter Measures/Counter-Counter Measures (CM/CCM) and acoustic analyses that were used for data certification purposes in operational analyses prior to the Field Experiment.

B. Top-Level Flow-down

In order to determine what questions describe operational potential for the RFPI HSOK concept, the OSD definition of military utility was set as the standard for comparison to the RFPI Management Plan, and was allocated into Issues and Criteria in the RFPI Functional Dendritic.

1. Military Utility Definition

Military utility is defined by OSD in the ACTD Master Plan in the following excerpt from the paragraph entitled "Measures of Effectiveness (MoE) and Measures of Performance (MoP):"

> "It is vital that the limited resources available to an ACTD be directed toward the evaluation of the military utility of the capability being evaluated. There are two aspects of military utility. The first deals with the question of how important the intended mission is to the outcome of the conflict or the military operation. This question can only be addressed from the integrated perspective of the operational user. The second deals with the issue of how effectively the capability under evaluation performs the intended mission and how suitable is it for use in military operations. To address this second aspect, it is important to define at the beginning of the ACTD those measures of effectiveness and performance (MoEs & MoPs) that will be considered to determine effectiveness and suitability."

Not only does this paragraph provide the definition of military utility, but it also suggests the development of MoEs and MoPs that focus on the second aspect of this definition. In keeping with the OSD suggested approach, the RFPI program addressed the first aspect, mission importance, through subjective user assessments, while the analysis effort focused on the second aspect, which includes mission effectiveness and suitability.

These sub-elements of the second aspect of military utility are defined by Army Regulation (AR 73-1):

> Operational effectiveness: The overall degree of mission accomplishment of a system when used by representative personnel in the environment planned or expected…for operational employment of the system considering organization, doctrine, tactics, survivability, vulnerability, and threat…

Operational suitability: The degree to which a system can be satisfactorily placed in field use with consideration given to availability, compatibility, transportability, interoperability, reliability, wartime usage rates, maintainability, safety, human factors, manpower supportability, logistic supportability, and training requirements.

2. Management Plan Definitions

The OSD and Army definitions given above apply directly to RFPI-specific measures and capabilities, as defined in the RFPI ACTD Management Plan. The primary Measure of Success (MoS) for RFPI is defined in the Management Plan as follows:

> "The primary MoS is to improve the survivability of airlift-constrained early entry forces in the hasty defense scenario…This requires demonstration of lightweight functionality permitting successful engagement of attacking armored vehicles at ranges beyond the close battle."

A set of interim MoSs was provided in the Management Plan, based on the primary MoS, and intended to provide quantitative goals for an otherwise unquantified primary measure. The interim set includes three explicit MoSs (increased situational awareness, increased lethality, and increased survivability), and a key assumption of airlift constraint that also drove analytical requirements.

The RFPI Management Plan states that the interim MoSs "will be refined…to adequately describe system performance with the necessary analytical robustness." In an OSD meeting with the RFPI joint managers in January 1997, these MoSs were refined to eliminate artificial minimum requirements (which incorrectly implied the existence of ACTD exit criteria) and to delete a methodology qualifier on the first MoS. In order to distinguish from the original interim MoSs, these revised measures are termed Assessment Measures. The goal values were revised from the original Management Plan based on O&O Concept Analysis, and approved by the Joint Managers. The Assessment Measures list is given in Table 1. The given conditions for these measures, as stated in the Management Plan interim MoS list, are airlift-constrained blue forces against a red force that overwhelms and defeats the blue base case.

Table 1. Interim ACTD Assessment Measures

Assessment Measure	Goal (Improvement over base case)
A. Increase situational awareness of the size and location of the threat array	50 – 100%
B. Destroy initial target array beyond 3 km	50 - 75%
C. Increase the survivability of the brigade	20 - 45%

In addition to Assessment Measures, the RFPI Management Plan identifies ACTD issues as follows:

Required Operational Capabilities:

(1)	Increased Survivability
(2)	Increased Lethality
(3)	Increased Target Acquisition
(4)	Increased Control of Battle Tempo

Operational Suitability:

(5)	Transportability and Deployability
(6)	Affordability

Required Operational Capabilities supports the evaluation of operational effectiveness. Operational Suitability considers employability by the unit and relates these and other suitability issues to operational effectiveness through the overall degree of mission accomplishment.

3. Functional Dendritic Issues and Criteria

From the Assessment Measures and Required Operational Capabilities in the Management Plan, the program developed the RFPI Functional Dendritic, which flows down and expands the Management Plan elements into Issues and Criteria which can be answered through established MoEs and MoPs, through meeting Data Requirements (DRs), by collection of specified Data Elements (DEs), as shown in the hierarchy in Table 2. The format of the Functional Dendritic Issues and Criteria is commensurate with that specified in Draft DA Pam 73-1.

Table 2. Dendritic Hierarchy

x. Issue
x.x Criterion
x.x.x Measure of Effectiveness*
x.x.x.x Measure of Performance
x.x.x.x.x Data Requirement
x.x.x.x.x.x Data Element
*note: not all Criteria include MoEs, elevating the remaining hierarchy one level where impacted

The mapping of the Assessment Measures and Required Operational Capabilities from the Management Plan against the Issues and Criteria of the Functional Dendritic are given in Tables 3 and 4. The mapping of the Functional Dendritic Issues and Criteria against the OSD definition of military utility is derived from the relationships above and is given in Table 5.

Table 3. Mapping of Dendritic Issues to RFPI Management Plan

#	Issue	Derivation
1	As compared to the baseline force, is the RFPI-equipped task force more survivable?	Required Operational Capability 3
2	As compared to the baseline force, is the RFPI-equipped task force more lethal?	Required Operational Capability 1
3	As compared to the baseline force, does the RFPI-equipped task force have increased target acquisition capabilities?	Required Operational Capability 2
4	As compared to the baseline force, does the RFPI-equipped task force have increased control of battle tempo?	Required Operational Capability 4
5	Is the RFPI-equipped task force rapidly air-deployable by strategic airlift; can the RFPI-equipped task force be moved using theater (C-130) and tactical lift (helo) assets?	Required Operational Capability 6
6	Are the RFPI systems affordable?	Required Operational Capability 5
7	Are the RFPI systems Operationally Suitable ?	Required Operational Capability 6

Table 4. Mapping of Dendritic Criteria to RFPI Management Plan

#	Criterion	Derivation
1	The RFPI-equipped task force must increase the survivability of the Brigade by 20 - 45% (goal).	Assessment Measure C
2	The RFPI-equipped task force must increase destruction of the initial threat target array outside 3 Km of the FEBA by 50 - 75% (goal).	Assessment Measure B
3	The RFPI-equipped task force must demonstrate sensor-shooter timelines of 15 - 120 sec (goal).	Required Operational Capability 4
4	The RFPI-equipped task force must increase situational awareness of the size and location of the threat array by 90 – 100% (goal).	Assessment Measure A
5	The RFPI-equipped task force must demonstrate a 25 – 50% (goal) decrease in the time required for the command decision cycle.	Required Operational Capability 4
6	The RFPI-equipped task force must demonstrate a 25 – 50% (goal) decrease in time required to respond to and disseminate information.	Required Operational Capability 4
7	The RFPI-equipped task force must meet DA standards for deployability of early-entry forces (DRB closure at C+4 days).	Required Operational Capability 6
8	All RFPI components must be C-130 transportable.	Required Operational Capability 6
9	All RFPI components, except HIMARS, must be helo-transportable.	Required Operational Capability 6
10	All RFPI components must be employable by the unit during the residual phase	Required Operational Capability 6

Table 5. Mapping of Dendritic Issues and Criteria to Military Utility

RFPI Dendritic Issue	RFPI Dendritic Criterion	OSD Military Utility		
		Aspect 1	Aspect2	
		Importance*	Effectiveness	Suitability
1			X	
	1		X	
2			X	
	2		X	
	3		X	
3			X	
	4		X	
4			X	
	5		X	
	6		X	
5				X
	7			X
	8			X
	9			X
6**				
7				X
	10			X

* note: aspect 1 will be evaluated by subjective user assessments

** note: affordability will be assessed, but is not directly related to military utility

These Functional Dendritic Issues and Criteria then defined the questions that enabled decision makers to assess the operational potential for the RFPI HSOK concept. When broken down to the MoE, MoP, Data Requirement, and Data Element level, these dendritics were mapped against the planned program analytical and experimental events to ensure that the proper data is collected and analysis is conducted to answer the questions posed.

C. Analytical Process

The RFPI ACTD Management Plan called for a Model-Test-Model methodology to be used to refine the interim MoSs, employing “constant force structure, scenario, and terrain throughout.” This prescribed methodology was expanded into a Model-Experiment-Model (M-E-M) methodology which considers multiple force structures, tactical and test scenarios and a variety of terrain types to more fully evaluate the operational effectiveness of the RFPI HSOK concept across the spectrum of early entry operations defined in ROC 6. The M-E-M process iterates about not only the FY98 Field Experiment, but also includes technical and operational experiments in order to produce evolving performance predictions while refining the modeling process and providing data for certification as system and simulation architectures are being developed and integrated. The Verification, Validation, Accreditation (VV&A) process certifies models and data for use in program events, and the assessment process determines the degree to which the program events answer dendritic issues and criteria.

1. Analytical and Experimental Events

The RFPI analytical and experimental events, as given and described in the RFPI ACTD DEMP, are grouped into six categories: (1) ATDs & TDs, (2) Force Analyses, (3) Engineering Analyses, (4) System of System Experiments, (5) RFPI Field Experiment, and (6) Residual Period. Each of the events across these categories inherently served one or more of three functions in support of analysis and execution of the program, as shown in Table 6.

Table 6. Event Functional Matrix

Program Event		Program Function		
Category	Event	Data Certification	Integration	M-E-M
ATDs & TDs	ATDs & TDs	X	X	X
Force Analyses	Interim Study	X		
	Quick Look Analysis			X
	O&O Concept Analysis			X
	TRAC-WSMR Tradeout Analysis			X
	RAND CM/CCM Studies	X		
	RAND Acoustic Studies	X		
	Pre-Field Experiment Analysis		X	X
	RFPI Vulnerability Assessment	X		X
	Post-Field Experiment Analysis			X
Engineering Analyses	RFPI ACTD Communications Experiment (RACE)		X	
	C3 Analysis	X	X	X
	System-Of-Systems Architecture (SOSA) Integration		X	X
System of Systems Experiments	Early Version Demo (EVD)		X	
	Warrior Focus AWE			X
	Anti-Armor (A2) ATD Experiment #6	X	X	
	RFPI Integrated Virtual Environment Test (RIVET)		X	
	Enhanced Fiber Optic Guided Missile (EFOGM) BLWE	X		X
	Multiple Semi-automated Force Integration Test (MSFIT)	X	X	
	Light Digital Tactical Operations Center (LDTOC) BLWE		X	X
	RFPI Virtual Rehearsal BLWE	X	X	X
	Pre-RFPI Field Exp Virtual Runs	X	X	X
RFPI Field Experiment	RFPI Field Experiment	X		X
Residual Period	Residual Period	X		X

a. Data Certification Events

Those items in Table 1 associated with data certification are events that had the potential to produce data for use in other program events. Data certification events contribute to analysis through the VV&A process, in addition to whatever inherent integration and M-E-M contributions they offer.

b. Integration Events

Those items in Table 1 associated with integration were events that had the potential to produce products, architectures, or processes used to conduct other program events. Integration events contribute to analysis by enabling and reducing execution risk of data certification and M-E-M events, in addition to whatever inherent data certification and M-E-M contributions they offer.

c. Model-Experiment-Model (M-E-M) Events

Those items in Table 1 associated with M-E-M are the primary events providing data sufficient to address the RFPI Functional Dendritic, in addition to whatever inherent data certification and integration contributions they offer. Some of these events provided interim answers that were revised by subsequent events. These M-E-M events comprised the primary set of events that provided data to support the assessment process.

This report maps the M-E-M events against the dendritic to identify which MoPs were addressed by which events, and against the dendritic Data Elements to identify what data collection requirements existed for each event, and which agencies conducted assessments from the appropriate data from each event.

2. Model-Experiment-Model (M-E-M) Process

The M-E-M process as shown in Figure 2 was utilized to produce the data to drive evolutionary assessments of military utility. Verification and validation of models, certification of analysis data, and accreditation of models and data for use in individual events coupled to the M-E-M process so that many issues and criteria could be assessed to the appropriate level of fidelity prior to the field experiment and subsequent final analyses. Level of fidelity was driven by the MoPs to be addressed, and the classification of the data required to address the MoPs.

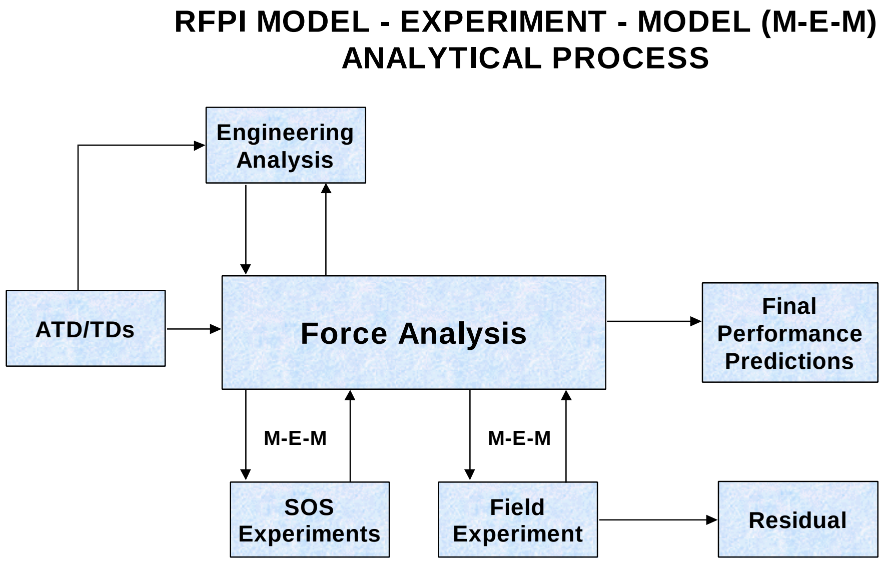

Figure 2. M-E-M Process

The first "M" in M-E-M is constructive modeling used to help develop robust and comprehensive scenarios for the experiment. Robustness ensures that the model can be used to prove whether or not a proposed experimental scenario has the potential for the RFPI force to demonstrate a significant increase in combat effectiveness over that for the baseline force. Comprehensiveness determines whether the scenario has the potential to address the critical study issues. If the scenario proves to be insufficient with respect to those two criteria, the scenario developers must make adjustments accordingly.

In the second "M", after the experiment is performed, the constructive model is calibrated until it can replicate the experiment within reasonable tolerances. Once the replication of the experiment is achieved and the model results are accredited and certified, the model can then be used to extend the experiment results to address issues that could not be addressed based solely on live/virtual results. Also the model, once calibrated to the RFPI force results, can be used to predict the baseline force results instead of actually doing that in a live experiment.

a. VV&A Process

Verification and validation of models was accomplished through the review of simulation algorithms, methodologies, and class accreditation of specific tools for the types of events included in the program. AMSAA was the agency within the U.S. Army with responsibility for verifying and validating the data used.

Certification of analysis data was accomplished through the detailed review of system performance algorithms; performance data; implemented tactics, doctrine, force structure, threat, scenario, and terrain; and underlying simplifying assumptions by ATD/TD managers, Training and Doctrine Command (TRADOC) users and proponents, RFPI simulation and analysis managers, and independent agencies.

Accreditation of models and data for use in individual events was accomplished by the joint ACTD managers based on the verification, validation, and certification activities stated above. Agencies conducting assessments independently accredited results of these events for inclusion in their assessments.

b. Performance Data Classification

In the M-E-M process, classified data was used only where needed to address specific MoPs, in order to reduce costs and complexities of events that would be prohibitive to execute in a classified environment. Specifically, the cost and complexity of conducting a classified or multi-level-security ACTD Field Experiment was prohibitive. Due to the fact that the vast majority of representations in the Field Experiment were virtual, properly defined classified virtual-only events were utilized to address performance questions that could only be answered using classified performance data, focusing the live-virtual activities on questions that can only be addressed with live sensors and weapons in the field. Since there were no live missile flights during the brigade portion of the Field Exercise, and since the live OPFOR consisted of surrogate vehicles, classified live engagement and target acquisition performance was not even achievable in the context of the Field Experiment, and was addressed through virtual and constructive simulation.

In order to assess the impact of this approach, the following is excerpted from an memorandum entitled, "Impact of Conducting RFPI Experiments with Unclassified Data:"

> "Classified performance data [for RFPI] includes target acquisition data, delivery accuracy data, and direct and indirect fire lethality data. The classified data represents the best estimate of the true or anticipated capability of each system. By definition, the unclassified data is less representative of each system. While unclassified data attempts to maintain the relative ranking of performance between systems, it does not always succeed. There is no standard method to translate between classified and unclassified performance data. (If it is possible to derive the classified data from an "unclassified" data set, then that data set cannot be considered unclassified.)
>
> Using unclassified data in a study limits the conclusions that can be drawn from that study. It would be inappropriate to draw any conclusions on force or system effectiveness. In addition, conclusions regarding the timeliness of intelligence might be tainted by inaccurate target acquisition data.

AMSAA has reviewed the RFPI issues… and many of those issues cannot be addressed in an unclassified experiment… If the logistical difficulties with conducting a classified field experiment cannot be overcome, AMSAA recommends the following:

a. That a common set of unclassified performance data be used in all simulators and computer generated forces in the experiment.

b. That no conclusions regarding force or system effectiveness be drawn from the unclassified experiment.

c. That issues that cannot be addressed in the unclassified experiment be examined in a classified virtual experiment or in constructive simulation."

The AMSAA document then itemizes which RFPI Functional Dendritic MoPs may be addressed fully, partially, or not at all in an unclassified experiment. This delineation, and AMSAA's recommendations, impacted the mapping of dendritic elements to M-E-M events. While force and system effectiveness measures were mapped to the field experiment, they were only to provide additional insight to the results from classified virtual experiments and constructive simulation. By using "training" quality approximations of performance data in unclassified experiments, the complexity of the brigade-sized fight dominated performance of the RFPI force as a whole, giving a very meaningful measure of the contribution of the RFPI system-of-systems. However, in keeping with the AMSAA recommendations, conclusions on the relative contributions of individual systems were not drawn from unclassified experiments, but assessed in classified virtual and constructive simulations.

c. Baseline Comparisons

RFPI Functional Dendritic Issues # 1 through 4 and Criteria # 1, 2, 4, 6 were measured in terms of comparative improvement of the RFPI-equipped task force over the baseline force. In order to address these elements, substantial analytical data were collected on baseline force performance in the areas of survivability, lethality, target acquisition, and battle tempo. In keeping with the unclassified nature of the field experiment, the first three elements of this baseline force comparison were not accomplished through live simulation. Therefore, constructive and virtual pre- and post-field experiment events were used to define the baseline performance for comparison of these elements. The battle tempo element for RFPI was focused on measurements at the brigade Tactical Operations Center (TOC), thus the live participation of brigade staff was the key contributor. These live role-players were assessed within the virtual pre- and post-field experiment events. With this approach for conducting the baseline comparison, there was no requirement to conduct a parallel baseline run of the field experiment with live sensors and weapon systems. However, baseline training activities of the user division were monitored for the purposes of data certification of baseline command and control performance parameters. Specifically, data was collected on the 101st Airborne Division (Air Assault) in a training exercise prior to the delivery of RFPI systems, as well as baseline exercises in support of OPTEC assessment.

d. Scenario Excursion Certification Process

Director, TRAC is the executive agent for development of scenarios for use in studies and analyses. The Director, TRAC certifies the modification of standard scenarios (i.e. excursion scenarios) and verifies the loading of scenarios into various models. Scenarios contain three major elements: the Red operational scenario, the Blue operational scenario, and the dynamic scenario. An Excursion scenario is a modification to a standard TRADOC scenario certified by HQ TRADOC or TRAC and approved for use in a specific study as the study's base case. All Excursion scenarios must be submitted by the study director to TRAC for certification

Detailed certification involves the following process: Prior to the study beginning analysis, TRAC FLVN (Ft Leavenworth) coordinates with doctrinal proponents to review and certify the scenario to ensure that a reasonable conflict exists and it meets operating standards (Appendix C, TR 71-4). TRAC verifies the adaptation and implementation of the scenario for use in the study to ensure that the model simulates actions specified in the standard scenario (i.e. no gross discrepancies such as the Red force attacks in the excursion when it defended in the base case, approved scenario). Finally, the TRAC and TSD POCs view a playback and review simulation results (killer-victim scoreboards.) Director, AMSAA, upon request, provides review data for particular study efforts to ensure that data and methodologies are up-to-date with the current system capabilities.

Operating standards for excursion scenarios include the following: The scenario must depict appropriate conflict situations consistent with approved concepts and doctrine. It develops from an approved and currently valid standard scenario. It employs Blue forces using Force XXI Operations and approved operational concepts of each service unless the study is examining new operational concept. It employs Red and unaligned forces using appropriate doctrine. The scenario must apply sufficient force ratios, as appropriate, to the particular study to other situations. It considers and incorporates as appropriate aspects of weather, climate, topography, vegetation, and other locational features. It reflects only the modifications directed in the study tasker and approved by SMEs. The scenario does not bias the study results and simulation results are comparable to other studies. TRADOC must review the scenario and certify Blue and Red force structures and doctrine. Finally, the scenario must receive the study sponsor's approval for use in the specific study.

For final certification, TRAC and TSD POCs review the scenario OPORDs, Order of Battle (Red, Blue, unknowns), firer-target matrix, and weapons munitions list. Any necessary limitations (simulation model does not incorporate dynamic terrain) or assumptions (Blue fixed wing aircraft not available due to Red main attack 300km to the west) are considered. Finally, the TRAC and TSD POCs view a play-back of the gaming, narrated by the responsible individual. TRAC and TSD then prepare the approval in writing.

3. Assessment Process

The final analytical products of the RFPI ACTD were assessments by five agencies: (1) Operational Test and Evaluation Command (OPTEC) Assessments, including individual system, field experiment, and residual reports; (2) Training and Doctrine Command (TRADOC) User Assessment; (3) U.S. Army Forces Command (FORSCOM) User Assessment; (4) TRADOC Analysis Command (TRAC) Performance Assessment; and (5) Engineering Assessment. While the entire compliment of data certification, integration, and M-E-M event data and documentation was made available to the agents conducting these assessments, the M-E-M event documentation and data were the primary set of sources. As a further refinement, each of the assessments focused on different subsets of the M-E-M events. The focus applicability of program M-E-M events to each assessment is given in Table 7.

Table 7. Focus Events for Assessments

Program Event		Program Assessments				
Category	Event	OPTEC	TRADOC	FORSCOM	TRAC	Eng
ATDs & TDs	ATDs & TDs	X				X
Force Analyses	Quick Look Analysis		X			
	O&O Concept Analysis		X			
	TRAC Tradeout Analysis		X		X	
	Pre-Field Experiment Analysis		X		X	
	RFPI Vulnerability Assessment				X	
	Post-Field Experiment Analysis		X		X	
Eng Analyses	C3 Analysis					X
	SOSA Integration					X
System of Systems Experiments	Warrior Focus	X	X			X
	EFOGM BLWE	X	X			
	LD TOC BLWE	X	X			
	RFPI Virtual Rehearsal BLWE	X	X		X	
	Pre-RFPI Field Exp Virtual Runs		X	X	X	
Field Exp	RFPI Field Experiment	X	X	X	X	X
Residual	Residual Period	X	X	X	X	

a. OPTEC Assessments

The OPTEC Assessments cover both aspects of military utility. OPTEC assessed elements of operational effectiveness and suitability as shown in Table 8, based on information extracted from the OPTEC Assessment Plan:

Table 8. OPTEC Assessment, By Category

1. Operational Effectiveness	2. Operational Suitability
A. Mission Performance B. Survivability/Vulnerability	A. RAM B. Human Factors C. Training Requirements D. Logistics Supportability E. Compatibility F. Interoperability G. Manpower Supportability H. Wartime Usage Rates I. Safety

OPTEC has described their assessment activities as follows:

> "These system assessments will assess the progress toward achieving system requirements and resolution of issues, and may not cover all aspects of effectiveness, suitability, and survivability. System assessments are typically produced to support continuous evaluation and as input to non-milestone decisions.
>
> On the other hand, an operational assessment should not be misconstrued as an operational evaluation. Operational evaluations typically support milestone decisions, are produced for systems that are production representative, address issues of system effectiveness, suitability and survivability, and appropriate documentation (including identification of critical issues) is in place."

b. TRADOC User Assessment

The Dismounted Battlespace Battle Lab (DBBL) developed the TRADOC User Assessment with the support of the Integrated Concept Team (ICT). This assessment explored operational issues, with emphasis on operational concepts, tactics, techniques, training and overall operational effectiveness. The TRADOC User Assessment focused on results of Force Analyses, System-of-Systems Experiments including BLWEs, the ACTD Field Experiment and the Residual Period.

c. U. S. Army Forces Command (FORSCOM) User Assessment

The FORSCOM User Assessment was a predominantly subjective assessment conducted by the XVIII Airborne Corps element equipped with the RFPI residual equipment, which includes the only program measure of the first aspect of military utility. This assessment also provided subjective insights on the second aspect of military utility, with emphasis on suitability. The FORSCOM User assessment was based almost exclusively on hands-on experience with residual RFPI hardware and software, and demonstrated capabilities during residual training and possibly actual battle.

d. TRADOC Analysis Center (TRAC) Performance Assessment

The TRAC Performance Assessment was conducted by TRAC-WSMR and sponsored by DBBL with the support of RFPI Simulation and Analysis. This assessment was based predominantly on Force Analysis events, and provided the final and definitive measure of operational effectiveness of the RFPI HSOK concept in a variety of early entry force structures and scenarios, including system tradeoffs and the relative contributions of individual system components.

e. Engineering Assessment

The RFPI Chief Engineer, with the support of the Simulation & Analysis Manager and Test & Evaluation Manager conducted the RFPI Engineering Assessment. The Engineering Assessment was based predominantly on Engineering Analysis events, but also captured technical information about the C3, instrumentation, and live/virtual architectures used in the field experiment. This report assessed automated Command and Control processing, digital communications network capacities, real-time instrumentation, and real-time live/virtual integration.

III. ANALYTICAL PRODUCTS

A. Documentation Road Map

Data and results of individual events were managed separately by the agency responsible for conducting that event, as given in Table 9.

Table 9. Event Points of Contact and Documentation

Documentation Roadmap

Analysis Product	Agency	POC	Telephone	email
Interim Study	RFPI TPMO	G. Tackett	DSN 788-0398 CML 205-842-0398	gtackett@redstone.army.mil
	Documents:	*BEWSS Support of Rapid Force Projection Initiative*, Dec 94		
Quick Look Analysis	RFPI TPMO	G. Tackett	DSN 788-0398 CML 205-842-0398	gtackett@redstone.army.mil
	Documents:	Quick Look Analysis Briefing Chart Report		
	Data base:	BEWSS output files, Jun - Dec 95		
O & O Concept Analysis	RFPI TPMO	G. Tackett	DSN 788-0398 CML 205-842-0398	gtackett@redstone.army.mil
	Documents:	O & O Concept Analysis Briefing Chart Report, May 96 O & O Concept Analysis Rebaseline Briefing Chart Report		
	Data base:	BEWSS output files, Nov 95 - Dec 96		
TRAC Tradeout Analysis	TRAC WSMR	Dr. Paul Deason	DSN 258-1610 CML 505-678-1610	deason@trac.wsmr.army.mil
RAND CM/CCM Study	Rand Corporation	T. Herbert	310-393-0411	tom_herbert@rand.org
	Documents:	Final report, 1995		
RAND Acoustics Study	Rand Corporation	T. Herbert	310-393-0411	tom_herbert@rand.org

Table 9. Event Points of Contact and Documentation (Cont.)

Analysis Product	Agency	POC	Telephone	email
Pre-Field Experiment Analysis	RFPI TPMO	G. Tackett	DSN 788-0398 CML 205-842-0398	gtackett@redstone.army.mil
RFPI Vulnerability Assessment	JC2WC/PDA	LT D. Breedlove	DSN 969-4675 CML 210-977-4675	breedlov@dcci.com
	Documents:	*Technical Report on the Exploitable Set of Rapid Force Projection (RFPI) ACTD Vulnerabilities*, 31 Dec 96		
Post-Field Experiment Analysis	RFPI TPMO	G. Tackett	DSN 788-0398 CML 205-842-0398	gtackett@redstone.army.mil
RACE	RFPI TPMO	R. Gallman	DSN 788-6910 CML 205-842-6910	rgallman@redstone.army.mil
C3 Analysis	RFPI TPMO	R. Gallman	DSN 788-6910 CML 205-842-6910	rgallman@redstone.army.mil
SOSA Integration	RFPI TPMO	R. Gallman	DSN 788-6910 CML 205-842-6910	rgallman@redstone.army.mil
Early Version Demo	RFPI TPMO	R. Gallman	DSN 788-6910 CML 205-842-6910	rgallman@redstone.army.mil
Warrior Focus AWE	DBBL	COL Bosse	DSN 835-2310 CML 706-545-2310	bosset@benning-emh2.army.mil
	Documents:	Warrior Focus Advanced Warfighting Experiment (AWE) Assessment Report, OPTEC, 4 Mar 96		
Antiarmor ATD Experiment #6	AMSAA	M. McCarthy	DSN 298-6612 CML 410-278-6612	mmccarth@arl.mil
	Documents:	Anti-Armor Advanced Technology DemonstratioExperiment 6 Report", AMSAA Technical Report 599, Nov 96.		
RIVET	RFPI TPMO	G. Tackett	DSN 788-0398 CML 205-842-0398	gtackett@redstone.army.mil
	Documents:	RFPI Integrated Virtual Environment Test (RIVET) I and II Quick Look Test Reports, RFPI TPMO, 15 Sep and 29 Nov 95		

Table 9. Event Points of Contact and Documentation (Concl.)

Analysis Product	Agency	POC	Telephone	email
EFOGM BLWE	DBBL, EFOGM PMO	LTC Arneson B. Wheeler	DSN 835-7008 CML 706-545-7008 DSN 788-8670 CML 205-842-8670	arnesonj@benning-emh2.army.mil bwheeler@redstone.army.mil
	Documents	EFOGM Virtual Prototype Evaluation Data Analysis Report, 21 Oct 96 EFOGM Operational Concept Validation Report (TBP)		
	Data base:	DIS logger files		
MSFIT	RFPI TPMO	G. Tackett	DSN 788-0398 CML 205-842-0398	gtackett@redstone.army.mil
	Documents	*Assessment of Computer Generated Forces Interoperability for the Light Digital Tactical Operations Center Battle Lab Warfighting Experiment", AMSAA Division Note CI-10, Mar 97*		
LD TOC BLWE	DBBL	LTC Arneson	DSN 835-7008 CML 706-545-7008	arnesonj@benning-emh2.army.mil
RFPI Virtual Rehearsal BLWE	RFPI TPMO	G. Tackett	DSN 788-0398 CML 205-842-0398	gtackett@redstone.army.mil
Pre-RFPI field Experiment Virtual Runs	RFPI TPMO	G. Tackett	DSN 788-0398 CML 205-842-0398	gtackett@redstone.army.mil
RFPI Field Experiment	RFPI TPMO DBBL	R. Gallman LTC Arneson	DSN 788-6910 CML 205-842-6910 DSN 835-7008 CML 706-545-7008	rgallman@redstone.army.mil arnesonj@benning-emh2.army.mil
Residual Period	RFPI TPMO DBBL	R. Gallman LTC Arneson	DSN 788-6910 CML 205-842-6910 DSN 835-7008 CML 706-545-7008	rgallman@redstone.army.mil arnesonj@benning-emh2.army.mil
OPTEC Assessments	OPTEC	MAJ Offen	DSN 761-9164 CML 703-681-9164	offen@optec.army.mil
TRADOC User Assessment	DBBL	LTC Arneson	DSN 835-7008 CML 706-545-7008	arnesonj@benning-emh2.army.mil
FORSCOM User Assessment	XVIII Airborne Corps	Mr. Brown	DSN 236-8867 CML 910-396-8867	
TRAC Assessment	TRAC WSMR	Dr. Paul Deason	DSN 258-1610 CML 505-678-1610	deason@trac.wsmr.army.mil
Engineering Assessment	RFPI TPMO	R. Gallman	DSN 788-6910 CML 205-842-6910	rgallman@redstone.army.mil

B. Field Experiment Data Set

The scope of the instrumentation suite developed to support the field experiment was based on the collection of all relevant dendritic DEs, as mapped to that event in the RFPI Analysis Management Plan. In addition, a more generic set of data was required to conduct the real-time live/virtual integration and experiment control, and support engineering analyses. The end-product data set for the purposes of analysis was a computerized Data Element Library allowing those agencies conducting assessments to access the combinations of DEs required for them to assess their DRs and MoPs of interest. The development of the DE Library required varying degrees of data reduction on the part of the data collection agency. Some DEs are discreet, raw data elements, such as "Exercise/scenario start time." Others required reduction and relation of raw data, to include some data analysis, such as "Activity/cue by which blue system was detected." The DE Library also incorporated sufficient data correlation so that assessment agencies could associate each individual truth position and state, target acquisition, timeline, decision, and engagement datum with one another by mission thread, to the degree that individual events are traceable.

ACRONYMS

A2	Anti-Armor
ACTD	Advanced Concept Technology Demonstration
AIS	Autonomous Intelligent Submunition
AMSAA	U. S. Army Materiel Systems Analysis Activity
APEX	Advanced Prototyping, Engineering and eXperimentation
ASSI	Aerial Scout Sensor Integration
ATD	Advanced Technology Demonstration
AWE	Advanced Warfighting Experiment
AWEM	Advanced Warfighting Experiment Manager
BDE	Brigade
BDS-D	Battlefield Distributed Simulation - Development
BLWE	Battle Lab Warfighting Experiment
BOS	Battlefield Operating Systems
BEWSS	Battlefield Environment Weapon System Simulation
C2	Command and Control
C3	Command Control and Communications
CASTFOREM	Combined Arms Task Force Engagement Model
CECOM	Communications-Electronics Command
CM/CCM	Counter Measures/Counter-Counter Measures
CONUS	Continental U. S.
DA	Department Army
DARPA	Defense Advanced Research Projects Agency
DBBL	Dismounted Battlespace Battle Lab
DE	Data Elements
DEMP	Demonstration and Evaluation Master Plan
DIS	Distributed Interactive Simulation
DISC	DIS Center

ACRONYMS (Cont)

DISCSS	DIS Crew Station Simulator
DoD	Department of Defense
DOF	Degrees-OF-Freedom
DR	Data Requirements
EVD	Early Version Demo
EFOGM	Enhanced Fiber Optic Guided Missile
FEA	Front End Analysis
FFRDC	Federally Funded Research and Development Center
FLVN	Ft. Leavenworth
FO/FAC	Forward Observer/Forward Area Controller
FORSCOM	U. S. Army Forces Command
HIMARS	High Mobility Artillery Rocket System
H-SOK	Hunter-Standoff Killer
HSS	Hunter Sensor Suite
IBSAT	Integrated Battlefield Simulation and Analysis Team
ICT	Integrated Concept Team
IMF	Intelligent Minefield
IPPD	Integrated Product and Process Development
LAH	Lightweight Automated Howitzer
LDTOC	Light Digital Tactical Operations Center
LHG	Long Haul Gateway
LOSAT	Line-of-Sight Anti-Tank
LWTB	Land Warrior Test Bed
MANPRINT	Manpower Personnel and Integration

ACRONYMS (Cont)

M-E-M	Model-Experiment-Model
MITL	Man-in-the-Loop
MLR	Multiple Launched Rocket
ModSAF	Modular Semi-Automated Forces
MoE	Measures of Effectiveness
MoP	Measures of Performance
MoS	Measure of Success
MOSF	Military Operations Simulation Facility
MRDEC	Missile Research, Development, and Engineering Center
MSFIT	Multiple Semi-automated Force Integration Test
NVESD	Night Vision and Electronic Sensors Directorate
O&O	Operational & Organizational
OPTEC	Operational Test and Evaluation Command
ORA	Operational Requirements Analysis
OSD	Office of the Secretary of Defense
P3I	Pre-Production Planned Product Improvement
PGMM	Precision Guided Mortar Munitions
PoP	Proof of Principle
RAM	Reliability and Maintainability
RDEC	Research Development and Engineering Center
ROC	Required Operational Capabilities
RACE	RFPI ACTD Communications Experiment
RFPI	Rapid Force Projection Initiative
RIVET	RFPI Integrated Virtual Environment Test
RS	Remote Sentry
R/V	Real/Virtual

ACRONYMS (Concl)

SAF	Semi-Automated Force
SAF/DI	Semi-Automated Force/Dismounted Infantry
SELA	System Engineering Laboratory Addition
SGI	Silicon Graphics Inc.
SOSA	System-Of-Systems Architecture
STRICOM	Simulations, Training and Instrumentation Command
T&E	Test & Evaluation
TAFSM	Target Acquisition and Fire Support Model
TBP	To Be Provided
TD	Technology Demonstration
TOC	Tactical Operations Center
TPM	Technical Program Manager
TPMO	Technical Program Management Office
TRAC	TRADOC Analysis Command
TRADOC	Training and Doctrine Command
TTP	Tactics, Techniques, and Procedures
VV&A	Verification, Validation, Accreditation
WSMR	White Sands Missile Range

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